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Snowmobiles as Utility Vehicles in the Arctic: Current Performance and Prospects for Improvement

Summary Report

Prepared for the
Transportation
Development Centre
Transport Canada

May 1982

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SNOWMOBILES AS UTILITY VEHICLES IN THE ARCTIC:

Current Performance and Prospects for Improvement.

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P.J. Poole Ph.D.

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17. Abstract A research study precipitated by reports of escalating costs of snowmobile acquisition and operation in the Canadian Arctic, accompanied by decreasing utility as working machines. The objective was to estimate the prospects for developing a more suitable machine for Inuit use. Historical surveys revealed, declining sales, fewer manufacturers and models, and a convergence in design since 1970 - with present sales about 25% of that peak year. The Inuit market is only 1% of the total but is comparatively stable. Technical research indicated that accumulated engineering knowledge is sufficient to design a suitable utility machine but such a model would be unlikely to appeal to the mass of recreational users. Moreover, current commitments to large volume production prohibit small-volume specialised manufacture at reasonable cost. As an example, a general description was given of a utility machine with the emphasis upon pulling power and durability and a simplicity of construction based upon a modular approach to design and assembly. It was concluded that the economic/design problems posed by present methods of mass production might be circumvented by evolving a production/assembly process viable for local, small-scale manufacture. An investigation into the feasibility of such a course of action was recommended as a follow-up to this study. It was further suggested that this be undertaken as a collaboration between a team of engineers and representative Inuit organisations.

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17. Résumé

Cette étude fait suite à l'observation du coût croissant et de l'utilité décroissante des motoneiges utilisées dans l'Arctique. On a voulu évaluer les possibilités de production d'un véhicule mieux adapté aux besoins des Inuits. Une revue du marché de la motoneige indique une décroissance des ventes ainsi qu'une réduction des modèles disponibles et des manufacturiers: les ventes sont présentement à 25% du niveau de 1970. Le marché Inuit n'en représente que 1% mais demeure stable. L'étude démontre que l'expertise existe pour la conception d'une motoneige arctique, mais que ce véhicule utilitaire ne pourrait plaire à la majorité des utilisateurs sportifs. De plus, les impératifs industriels ne permettraient pas la production à un prix raisonnable d'un véhicule de petite diffusion. Pour illustration le rapport définit les spécifications générales d'une motoneige utilitaire, mettant l'accent sur la capacité de traction, la durabilité et la simplicité et fondées sur une construction modulaire.

Afin de contourner le dilemme quantité/coût il est proposé d'étudier un procédé d'assemblage faisant appel à la main-d'oeuvre Inuit. Ceci ferait l'objet d'une étude de faisabilité en collaboration avec des associations Inuits.

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FOREWORD

The issue of escalating costs of snowmobile acquisition and operation in the Canadian Arctic, without concommittant improvements in utility performance, was bought to light in the course of investigations by the Inuit Development Corporation into the prospects for expanding intersettlement trade between Inuit communities. The snowmobile/sled combination was one means of transport considered for this purpose.

Officials from the Arctic Transportation Directorate and the Transportation Development Centre expressed an interest in the work of the Inuit Development Corporation. The Transportation Development Centre responding to the "snowmobile problem" by sponsoring a project to investigate ways of resolving this issue. The Inuit Development Corporation was represented on the inter-departmental committee which reviewed progress on the project and. in addition, provided active assistance and encouragement while it was in progress.

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The design and production of snowmobiles is certainly dominated by the need to serve the recreational market, but a long-term, and continuing decline in that market is obliging manufacturers to pay more attention to the requirements of the very small but comparatively stable Arctic utility market.

2. This market is now being served by modifying certain recreational models and presenting them as "dual-purpose" machines. Thus, the potential for responding to utility requirements is limited by the scope these recreational models provide for modification.

3. The modifications undertaken by manufacturers are limited in that sense and also by the economics of production: how to produce small volume models or features at acceptable prices.

4. The methods by which snowmobiles are now produced prohibit the possibility of designing and manufacturing an entirely new utility snowmobile. For such purposes, users must rely upon two utility models that have been in production for over ten years.

5. The developments and changes that have occurred in the course of refining snowmobiles for recreational use have not always been disadvantageous for utility use, but, it appears that certain avenues of research which could have improved utility performance may have been inevitably passed by in favour of those with more promise for recreational performance.

6. The dual-purpose models recently introduced are providing improved utility performance, but not at lower cost. In fact, the continuing escalation in costs of aquisition and operation is likely to become the dominant factor in selecting future snowmobiles.

7. There may be scope for the small-scale production of a mid-size utility snowmobile if this were done by a simplified modular process of assembly. Such a machine might follow early snowmobiles in basic concept but would take advantage of improved technology and materials. It would not possess the speed or styling typical of current models.

Recommendations

1. If Conclusion No. 7 is to be acted on, the first step should be a study of its practical and economic feasibility and a comparison of the results with the production economics of present manufacturers.

2. This first step in a possible R&D program should only be undertaken if an Inuit or other organisation with a committed interest in the further development of the high Arctic assumes responsibility for coordinating such a program and acting at the interface between technologists and Inuit users.

1. INTRODUCTION

Over the past years the different manufacturers have invested untold moneys developing stable, fast, comfortable snowmobiles. Weight has always been a factor in gaining the final results. The lighter the final production unit is, the faster it eats up the trails, manoeuver turns and moguls and result in an overall more comfortable riding machine.

The original production machines that most of us cut our teeth on could be described as nothing more than anchors. They were assembled with heavy materials for a good reason - the type of terrain the sleds were called upon to cover. As much as we hate to admit it, before the trails systems became as expansive as they are today, the open fields, lakes and yes, even paved roads were the main snowmobile trails. . . .

In order to stand up to this type of punishment, the sleds were over-built. Today, what might be a thin aluminium bracket, ahd to be made of steel plate 15 years ago.

"Snowmobile Canada", 1982, 13(2):42-43
(emphasis added)

1.1. This study was precipitated by:

Complaints recorded by Inuit, Government and Scientific organisations that snowmobiles have become progressively less suitable for Arctic utility use while, at the same time, costs of acquisition and operation have escalated.

Such complaints have stimulated this investigation into the prospects for the "Development of a vehicle for light transportation tasks in the Arctic having an improved performance compared to modern snowmobiles".

To achieve this, the study is designed to examine the industry which produces the snowmobile as well as the views and comments of those who sell, repair and use them in the Arctic.

The study is being undertaken by the Transportation Development Centre of Transport Canada in collaboration with the Arctic Transportation Directorate.

The study concentrates upon snowmobile use north of the tree-line in the NWT and Quebec, taking note of the needs of communities along the tree-line. Field inquiries were pursued in the following communities: Fort Chimo, George River, Frobisher Bay, Pond Inlet, Cambridge Bay, Yellowknife, Tuktoyaktuk and Inuvik.

2. THE SNOWMOBILE INDUSTRY: 1960's TO THE PRESENT

2.1. Three major trends are apparent during this period.

A sharp sales increase of 600% between 1968 and 1971, followed

by a continual decline - interrupted only by a slight recovery between 1977 and 1979 (Figures 1-3).

A steady decrease in the number of snowmobile producers and models produced (Table 1).

A gradual convergence in the basic design of snowmobiles.

2.2. With excellent snow conditions 1981/82, it was hoped that sales would recover to 1977-79 range. But latest figures indicate a continuation in the decline. Apparent reasons are:

Economic: increasing prices of new machines and spares (Figure 4).

Economic: general recession and high interest rates; withdrawal from luxury purchases.

Economic: rising fuel costs.

Competition from 3-wheel off-road motor-bikes which can use snowmobile trails but also have greater terrain versatility and cost less. 3-wheeler sales may exceed snowmobile sales this year.

Poor image of snowmobile due to past problems with, noise, safety, environmental impact. Though these have been mitigated, it is conceivable that the sport attracts fewer new adherents.

Increasing popularity of cross-country skiing as a cheaper alternative promoting physical fitness.

2.3. Northern markets reflect fluctuations experienced in total market to a degree but also show signs of comparative stability:

Recent sales recovery has been more complete and levels are approaching those of the peak years (Figure 2).

Sales over the last five years have been more steady.

Sales in the NWT & Yukon actually increasing at present.

Though northern markets are comparatively low in volume, as a proportion of the total market they are increasing (Figure 3).

This proportion is at present at its highest level.

2.4. The number of manufacturers has fallen from 38 to 4 over the period 1970-83, number of models produced has also fallen.

For the 1982/83 season there will be only 4 manufacturers: Bombardier, Yamaha, John Deere, Polaris (Table 1).

The tooling investment (an estimate: $1,200.00) for a new model considerably higher now than the early 1970's, when snowmobiles were assembled more simply and readily.

2.5. Since the basic configuration of the snowmobile became established, there has been a gradual convergence in design.

Figure 1

SNOWMOBILE SHIPMENTS, 1964-1981: NORTH AMERICA, UNITED STATES, CANADA

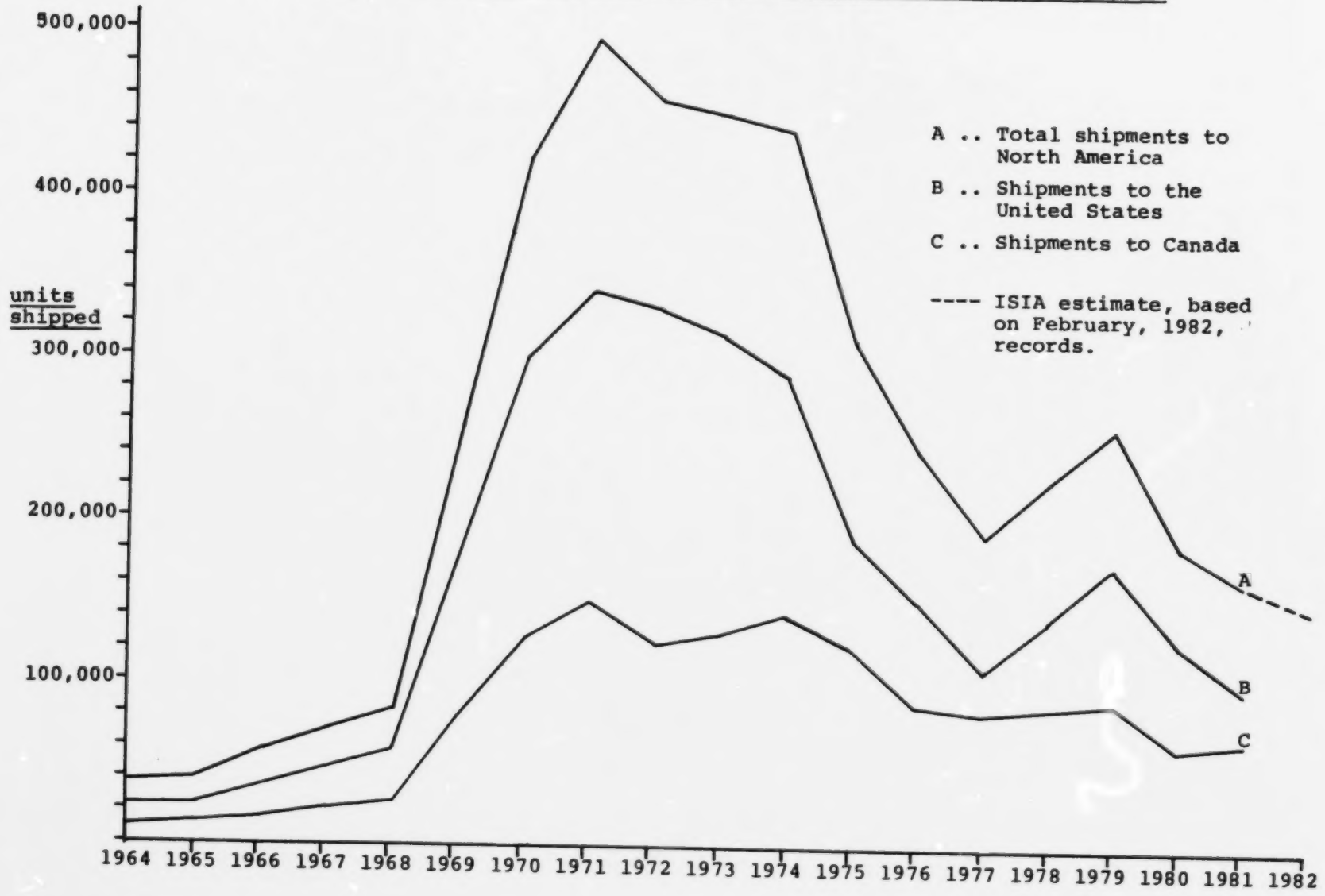

500,000
400,000
units shipped
300,000
200,000
100,000
1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982
A .. Total shipments to North America
B .. Shipments to the United States
C .. Shipments to Canada
---- ISIA estimate, based on February, 1982, records.
A
B
C

Figure 2

SHIPMENTS OF SNOWMOBILES TO NWT, YUKON, ALASKA, 1964-1981

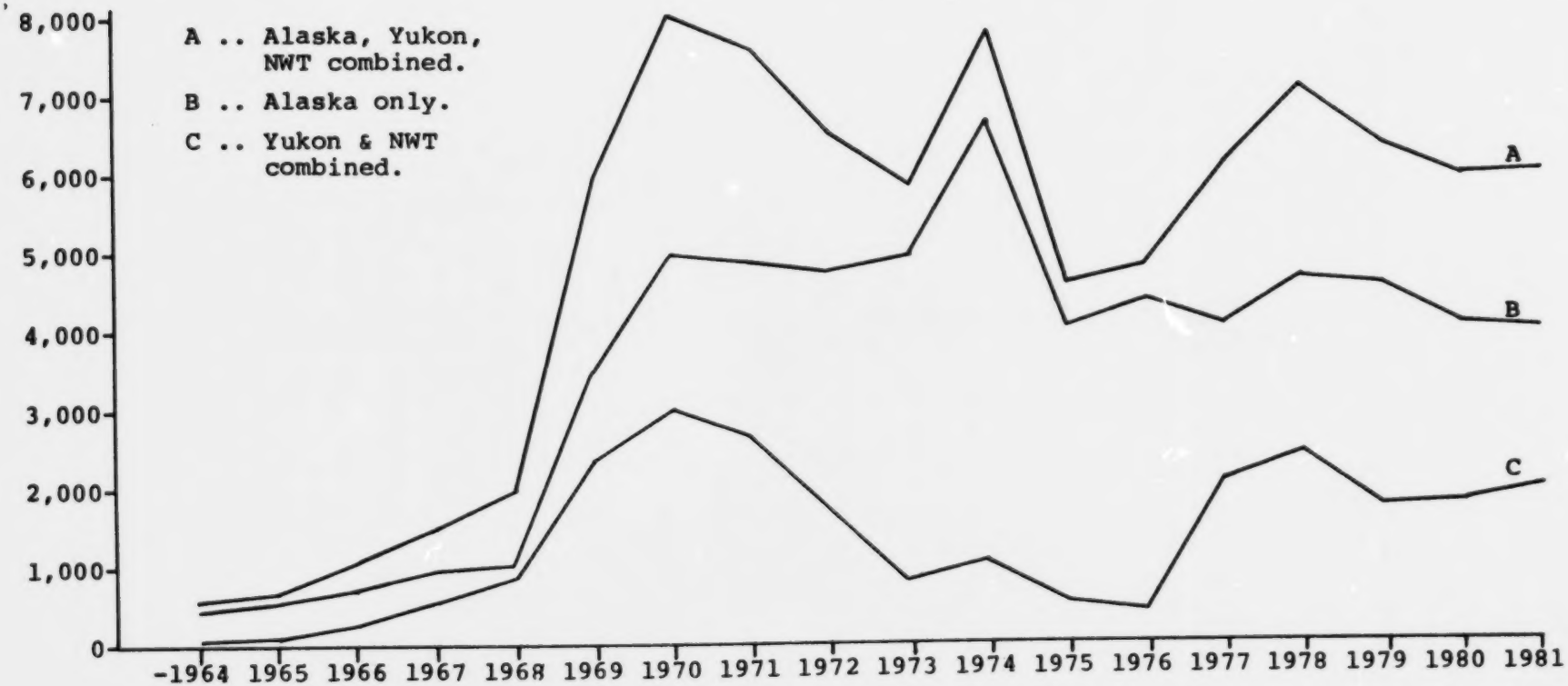
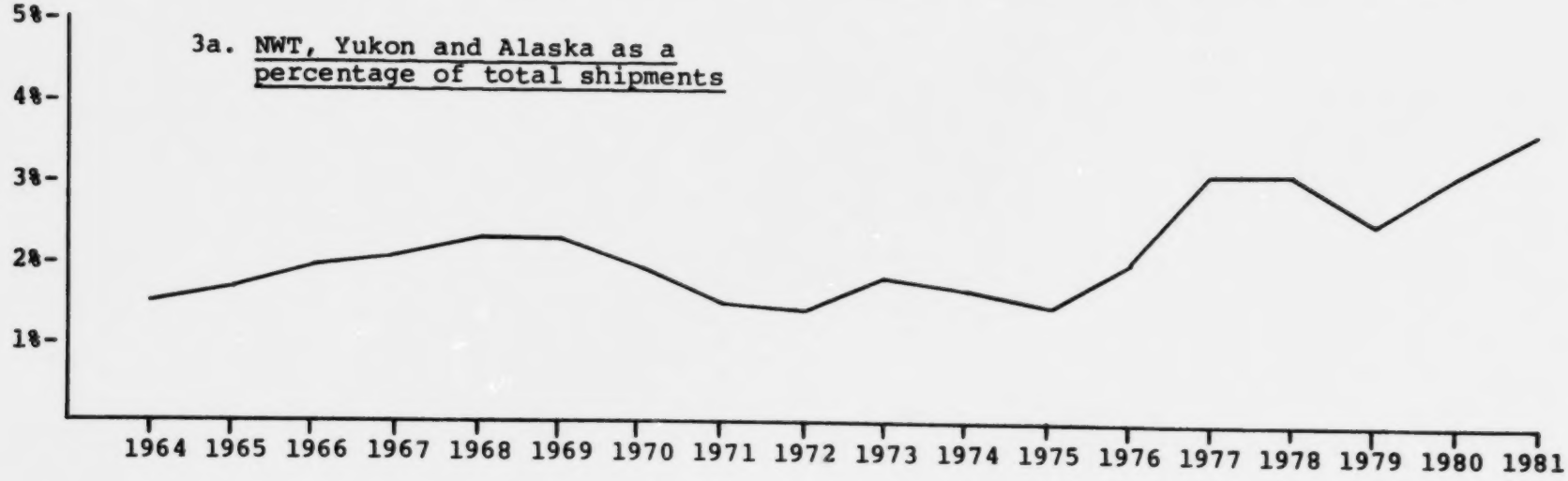
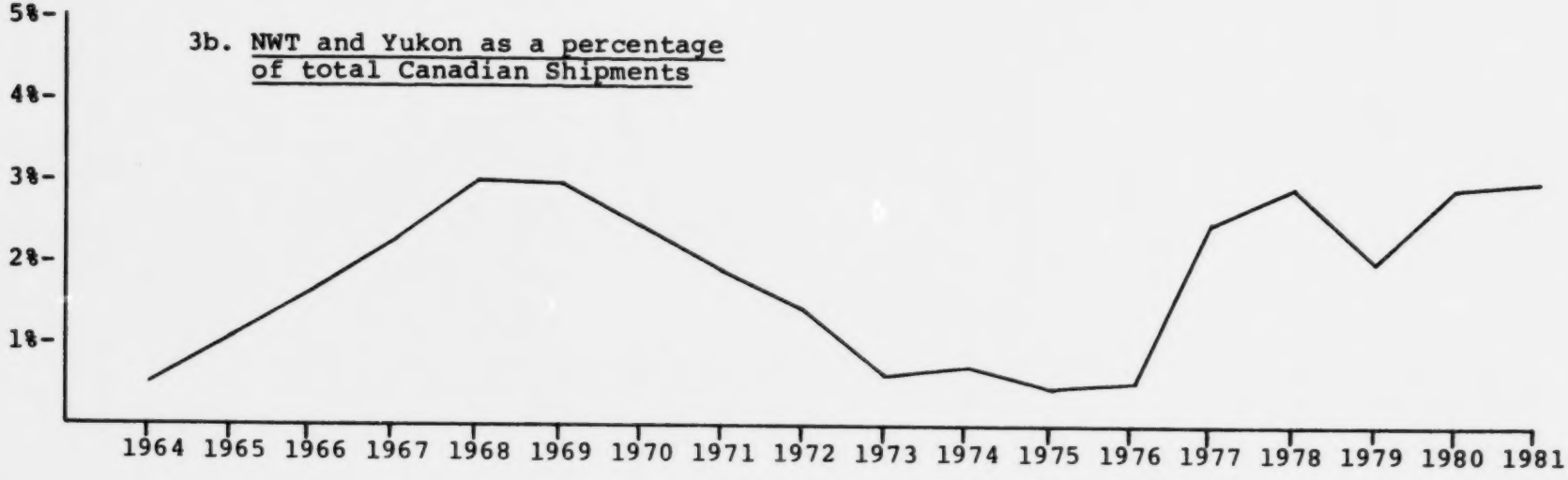


Figure 3

SNOWMOBILE SHIPMENTS TO NORTHERN MARKETS AS PERCENTAGES OF TOTAL SNOWMOBILE SHIPMENTS



3a. NWT, Yukon and Alaska as a percentage of total shipments



3b. NWT and Yukon as a percentage of total Canadian Shipments

Table 1

CHANGES IN THE NUMBER OF SNOWMOBILE PRODUCERS AND THE MODELS PRODUCED, 1970-82

Season	Number of producers	Location of producers				Models produced
		Quebec	Ontario	United States	Japan	
1970/71	38	8	1	28	1	258
1971/72	27	12	2	12	1	248
1972/73	28	10	1	16	1	235
1973/74	29	8	2	17	2	222
1974/75	23	8	1	13	1	145
1975/76	18	6	1	10	1	121
1976/77	10	1	1	6	2	75
1977/78	7	1	-	4	2	60
1978/79	7	1	-	4	2	54
1979/80	7	1	-	4	2	61
1980/81	7	1	-	4	2	54
1981/82	5	1	-	2	2	44
1982/83	4	1	-	2	1	N/A

Figure 4

PRICE RANGES OF MODELS OFFERED 1981/82

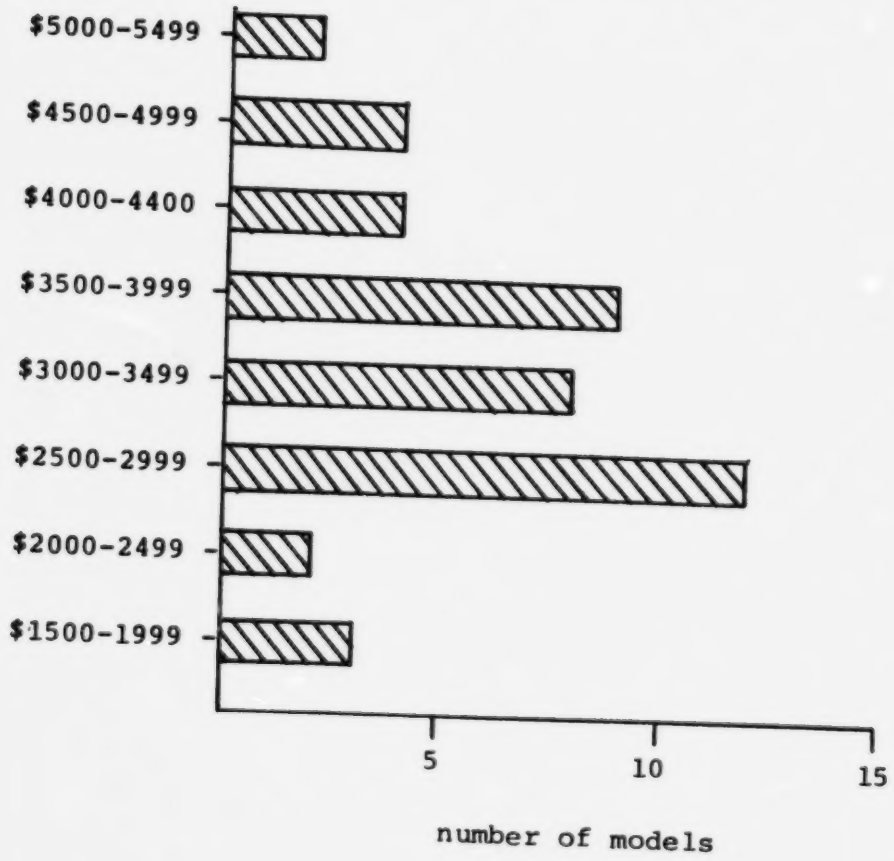


Table 2 shows the degree to which currently available models share the same major features.

Table 3 indicates how the range of available track widths has progressively narrowed to the dimension most suitable for recreational snowmobiling on groomed trails.

3. THE SNOWMOBILE INDUSTRY NORTH OF THE TREE-LINE (NWT & QUEBEC)

3.1. Snowmobile sales and distribution are dominated by three systems.

The Hudson's Bay Company buys Bombardier machines in bulk and retails them in most communities (Map 1.).

The NWT and Quebec Co-operative systems retail John Deere and Bombardier machines through many community outlets.

Recently, Yamaha has extended its number of dealerships, some of whom are now co-operatives.

Polaris is represented by very few dealerships.

Occasionally, individuals may undertake casual or 'one-time' dealing in snowmobiles.

3.2. Repair facilities and qualified mechanics are rare.

As a rule, neither the H.B.C. or Co-operative stores maintain repair facilities or keep mechanics on staff. This can lead to problems in the assessment of and compliance with warranty claims.

Mechanics and repair facilities are more likely to be found at the independent Yamaha dealerships.

Many owners prefer to carry out their own repairs and would prefer access to facilities over availability of mechanics as a way of improving the situation.

3.3. The supply of spare parts can be a serious problem.

While 'routine' parts (e.g. plugs, belts, sliders) may be readily available, owners may have to wait for several months for less ordinary replacements, for example, those that may be needed to overhaul a machine for a second year.

Estimates of replacement costs through a season of 'serious' use reach as high as $500.

Estimates of the cost of overhauling a machine for a second year of use may approximate half the cost of a complete replacement machine. This, coupled with the problem of getting the required parts and the comparative unreliability of an overhauled machine, contribute to owner's decisions to replace a snowmobile each year if possible.

3.4. An approximation is attempted of the size of the snowmobile market north of the tree-line (NWT & Quebec) (Table 4).

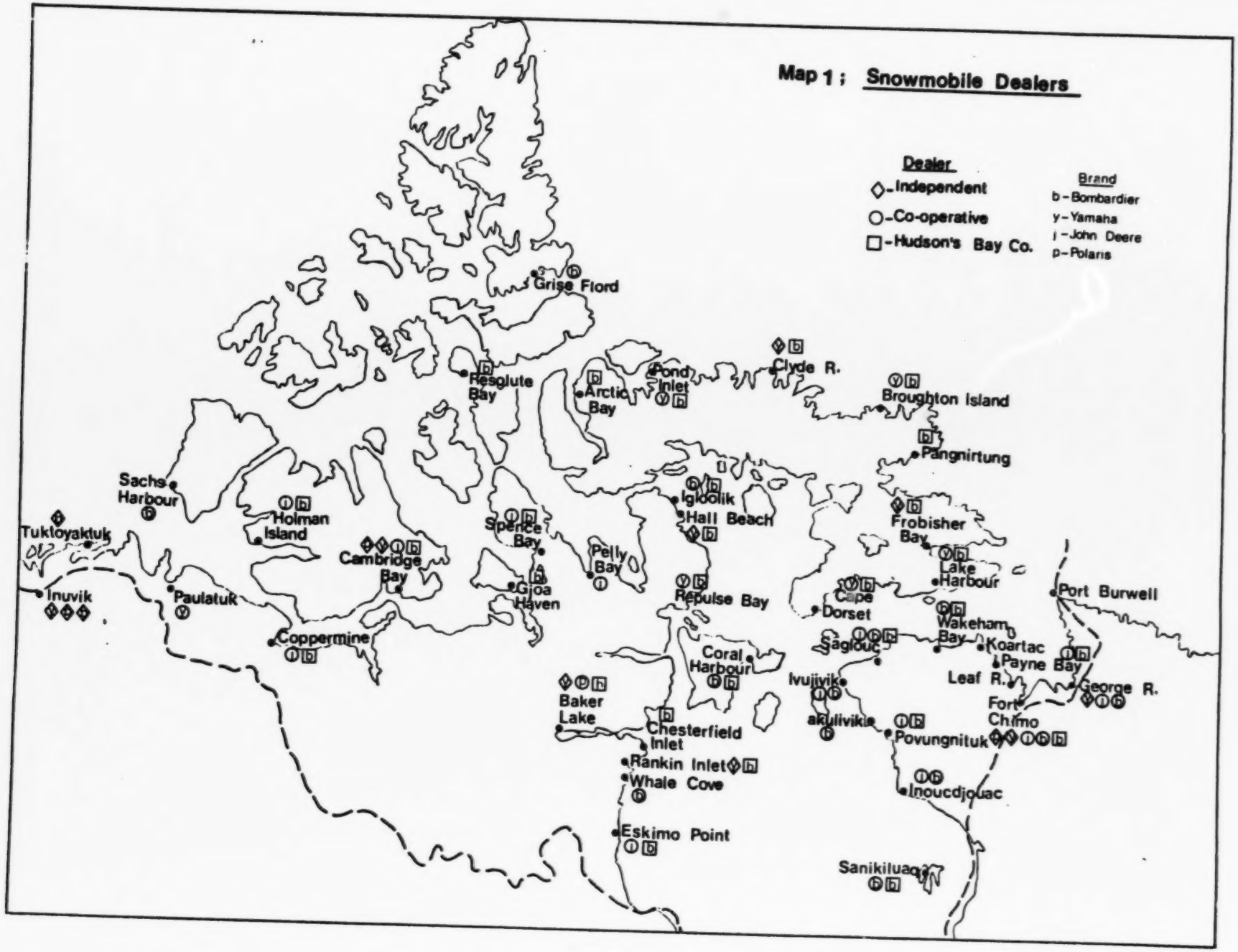

Map 1 ; Snowmobile Dealers
Dealer
◇-Independent
○-Co-operative
□-Hudson's Bay Co.
Brand
b-Bombardier
y-Yamaha
j-John Deere
p-Polaris
Grise Fiord
Resolute Bay
Arctic Bay
Pond Inlet
Clyde R.
Broughton Island
Pangnirtung
Igloolik
Hall Beach
Frobisher Bay
Lake Harbour
Port Burwell
Cape Dorset
Wakeham Bay
Koartac
Payne Bay
George R.
Leaf R.
Fort Chimo
Povungnituk
Inoucdjouac
Sagiouc
Ivujivik
akulivikia
Coral Harbour
Repulse Bay
Pelly Bay
Gjoa Haven
Spence Bay
Cambridge Bay
Holman Island
Sachs Harbour
Tuktoyaktuk
Inuvik
Paulatuk
Coppermine
Baker Lake
Chesterfield Inlet
Rankin Inlet
Whale Cove
Eskimo Point
Sanikiluaq

Table 2: CURRENTLY AVAILABLE SNOWMOBILE MODELS AND THEIR MAJOR ATTRIBUTES

		MAJOR DESIGN FEATURES											
	MODEL NAME	Weight k	Displacement cc	No. Cylinders	No. Carburetors	Cooling (A) air (F) fan (L) liquid	Starting (M) manual (E) electric E/M both	Ignition (C) CDI (B) breakers	Fuel Mixing (P) pre-mix (I) oil injection	Suspension (B) bogie (S) slider (P) pararail	Track length	Track width	Price $
	Bombardier												
*A *B	ELAN	129.2	250.4	1	1	F	M	B	P	B	289.6	38.1	1849
	CITATION 3500	156.6	268.7	1	1	F	M	C	I	S	269.2	38.1	1979
	CITATION 4500	169.3	368.3	2	1	F	M/E	C	I	S	289.6	38.1	2649
	CITATION SS	172.0	368.3	2	2	F	M/E	C	I	S	289.6	38.1	2949
*B	NORDIK	172.4	368.3	2	1	F	M	C	P	S	315.0	38.1	2849
*B	SCANDIC	193.4	368.3	2	1	F	M	C	P	S	353.0	38.1	2949
*C	EVEREST 500	208.2	496.7	2	1	F	M/E	C	I	S	315.0	41.9	3449
	EVEREST L/C	229.6	462.8	2	1	L	E	C	I	S	315.0	41.9	3999
	BLIZZARD 5500MX	190.9	496.7	2	2	F	M	C	I	S	289.6	41.9	3649

Table 2 : cont.

BLIZZARD 9500	200.0	43.6.	2	2	L	M	C	I	S	289.6	41.9	4349
*A ALPINE	292.8	635.1	2	1	F	E	B	P	B	353.0	76.2	4899
Yamaha												
*D BR250F	128.0	246.0	1	1	F	M	C	I	S	238.0	38.0	1699
BT300F	157.0	294.0	2	1	F	M	C	I	S	259.0	38.0	2249
*C ET340F	165.0	338.0	2	1	F	M	C	I	S	275.0	38.0	2599
EC340F	173.0	338.0	2	1	F	M/E	C	I	S	275.0	38.0	2800
*B ET340TF	184.0	338.0	2	1	F	M	C	I	S	342.0	38.0	2899
SS440F	181.0	437.0	2	1	F	M	C	I	S	294.0	38.0	3499
EC540F	218.0	535.0	2	1	F	M/E	C	I	S	317.0	42.0	3599
SR540F	N/A	535.0	2	1	F	M	C	I	S	307.0	38.0	3999
SKX500F	N/A	499.0	2	2	L	M	C	I	S	207.0	38.0	4899
John Deere												
SPITFIRE	129	338	2	1	A	M/E	C	P	S	295	38	2399
TRAILFIRE	174	339	2	1	F	M/E	C	P	S	295	40	3699
TRAILFIRE LX	176	436	2	1	F	M/E	C	I	S	295	38	3699
SPORTFIRE	179	436	2	1	F	M/E	C	I	S	295	38	3899
LIQUIFIRE	187	436	2	2	L	M	C	I	S	295	38	4899

Table 2: cont.

Polaris												
TXL340	181	333	2	2	L	M	C	P	S	307	38	4339
TXLINDY 340	193	333	2	2	L	M	C	P	S	307	38	4769
CUTLASS SS440	172	432	2	1	F	M/E	C	I	S	279	38	3399
TXC 440	178	432	2	2	F	M/E	C	I	S	307	38	3989
TXLINDY 500	181	500	3	2	L	M	C	P	S	307	38	5449
Kawasaki												
INTRUDER 440	190	436	2	2	F	M	C	I	S	307	38	3699
LTD440	200	436	2	2	L	M/E	C	I	S	307	38	4499
INTERCEPTOR 540	200	530	2	2	L	E	C	I	S	295	38	5199
Arctic Cat (1980/81 models)												
JAG4000	180	431	2	1	F	M/E	C	I	S	278	38	2899
*C PANTHER 5000	180	431	2	1	F	M/E	C	I	S	290	40	3199
TRAIL CAT	176	431	2	1	F	M/E	C	I	S	278	38	3399
PANTERA	177	500	2	1	F	M/E	C	I	S	278	38	3499
EL TIGRE 5000	174	500	2	2	A	M	C	P	S	278	38	3499

Table 2: cont.

EL TIGRE 6000	187	500	2	2	L	M	C	P	S	278	38	4199
Scorpion	(1980/81 models)											
TK340	169	339	2	1	F	M	B	P	P	284	38	2699
TK440	169	428	2	1	F		B	P	P	284	40	2699
WHIP	164	428	2	1	F	M	B	P	S	284	38	2599
STING 440	164	428	2	1	F	M	B	P	S	276	38	2799
SIDEWINDER	185	436	2	1	L	M	C	P	S	276	38	3999

Table 3: CHANGES IN TRACK WIDTHS OFFERED 1970-1981

track width		1970		1975		1977		1979		1981	
CMs.	INs.	No.	%	No.	%	No.	%	No.	%	No.	%
29.6	10.5	1	0.5	-	-	-	-	-	-	-	-
30.72	12.0	4	1.5	-	-	-	-	-	-	-	-
37.12	14.5	-	-	4	3.5	-	-	-	-	-	-
38.4	15.0	74	35.0	48	42.0	27	64.0	31	82.0	33	77.0
39.04	15.25	23	10.0	-	-	-	-	-	-	-	-
39.4	15.38	-	-	-	-	-	-	-	-	2	4.65
39.7	15.5	34	16.0	31	26.0	4	9.5	-	-	2	4.65
40.3	15.75	10	5.0	-	-	-	-	-	-	-	-
40.96	16.0	-	-	5	4.0	3	7.0	2	5.5	2	4.5
42.2	16.5	-	-	5	4.0	4	9.5	4	10.0	4	9.0
43.5	17.0	11	5.0	9	8.0	3	7.0	1	2.5	-	-
44.8	17.5	6	3.0	-	-	-	-	-	-	-	-
46.1	18.0	31	15.0	10	9.0	1	3.0	-	-	-	-
47.4	18.5	10	0.5	-	-	-	-	-	-	-	-
48.6	19.0	6	3.0	-	-	-	-	-	-	-	-
51.2	20.0	6	3.0	-	-	-	-	-	-	-	-
52.5	20.5	2	1.0	4	3.5	-	-	-	-	-	-
56.3	22.0	2	1.0	-	-	-	-	-	-	-	-
58.9	23.0	1	0.5	-	-	-	-	-	-	-	-
TOTALS		212		115		42		38		43	

To obtain the data collated in Table 4, shipment figures were obtained from one manufacturer. To supplement this, all H.B.C. and Co-operative stores or organisations were contacted, some of whom were disinclined to provide data. (We were requested not to provide a breakdown by producer).

The final estimate is in the range 15,00-1,600 for the study area.

When compared with current population estimates, NWT shows 1 new machine for each 16 inhabitants, Quebec 1 for each 13. Where individual community ratios depart from these figures, comments are inserted in the table.

Compared with estimates of the numbers of "adult hunters", the sales figures approximate, in the NWT, 1 new machine for every 2 hunters, in Quebec, 1 for every 1.5 hunters.

The 1,500-1,600 estimate approximates only 1% of the total 1981/82 market, but suggests a very high rate of turnover when compared to the population.

3.5. All four surviving manufacturers have made recent efforts to discover and respond to the needs of the Arctic utility market.

Polaris consulted users in Alaska, and then modified two current models as utility prototypes. Regional dealers approved of the design but were discouraged by the prices from ordering any.

John Deere consulted Canadian Inuit and produced the Arctic Trailfire Special. This is now available at a higher price than the current model from which it was derived.

Yamaha conducted research in Alaska and Canada leading to the production of the 340 TF "Trapper" model, now available.

Bombardier conducted research in Canada and Scandinavia, leading to the Scandic and Nordik models.

Arctic Cat had designed the Long-Track Jag for the Scandinavian users. Now withdrawn from production.

Collectively, the special features on these machines represent not just those requested by Arctic users but also those which could be accommodated within the economics of production of the manufacturers. Such economics exclude the possibility of increasing track widths, but include the following features: longer tracks, enlarged windshields, extra idling wheels, fuel primers, reinforced front suspensions, kick stands, stronger towing hitches, on/off light switches, fuel shut-off valves, de-tuned engines, reduced gearing.

These machines tend to be advertised as "dual-purpose" rather than utility machines. They are modified existing models, as manufacturers have stated that the market for a completely new utility vehicle is too small to support its production.

Table 4: COMPILATION OF DATA ON SNOWMOBILE SHIPMENTS AND THEIR RELATION TO POPULATION

SETTLEMENT	TOTAL SHIPPED	LOCAL POPULATION	RATIO: POPULATION SNOWMOBILES	COMMENTS
N.W.T.				
Igloolik	32	843	26	new management data uncertain
Pond Inlet	53	708	13	-
Resolute Bay	6	206	34	some ordered elsewhere
Lake Harbour	32	306	10	-
Clyde River	44	471	11	-
Broughton Is.	21	398	19	-
Arctic Bay	7	474	67	uncertain data
Grise Fiord	2	110	67	machines ordered elsewhere
Hall Beach	4	400	100	machines bought in Igloolik
Pangnirtung	72	995	14	-
Frobisher Bay	69	3255	47	-
Sanikiluaq	28	366	13	-
Rankin Inlet	108	1289	12	some sold elsewhere
Baker Lake	115	1163	10	-
Chesterfield In.	7	292	42	some bought in Rankin Inlet
Coral Harbour	51	532	10	-
Eskimo Point	41	1019	25	some bought in Churchill
Repulse Bay	34	338	10	-
Whale Cove	4	208	52	some bought in Rankin Inlet
Cape Dorset	79	782	10	-

Table 4: cont.

Cambridge Bay	108	969	9	some sold elsewhere
Coppermine	69	916	13	-
Holman Is.	29	349	12	-
Pelly Bay	1	295	295	most bought Cambridge Bay
Spence Bay	36	536	15	some ordered from Cambridge Bay
Gjoa Haven	28	519	18	-
Tuktoyaktuk	N/A	-	-	-
Paulatuk	15	183	12	some ordered elsewhere
Sachs Harbour	7	197	28	some ordered elsewhere
N.W.T. Sub-Totals	1,144	18,118	16	
Québec				
Great Whale	20	644	32	some bought elsewhere
Inoucdjouac	33	745	22	-
Fort George	0	69	-	ordered elsewhere
Povungnituk	41	704	17	-
Akulivik	26	188	7	-
Fort Chimo	138	976	7	some sold elsewhere
Leaf Bay	0	102	-	ordered elsewhere
George River	30	315	10	-
Payne Bay	30	277	9	-
Port Burwell	0	70	-	ordered elsewhere
Koartac	0	136	-	ordered elsewhere
Wakeham Bay	24	273	11	-

Table [4]: cont.

Ivugivik	20	179	9	-
Sugluk	40	495	12	-
Québec Sub-Totals	402	5,212	13	
TOTAL	1,546	23,330	15	

4. INUIT USAGE

> When they started getting skidoos, people decided that they could not keep their dogs going. When you try to keep dogs, the policeman just shoots that, so we turn to metal things that cannot be shot. You break them up yourself, or bump somebody with them. . . . By using a skidoo as your means of transportation, you tend to sharpen your own senses: smell, eyes, your sense of direction in the dark or in a storm, and your prediction of weather. These things were not really sharp before, because you had dogs. If you were going to go somewhere, they would probably know which way to go anyway, because all the things your knew went to the leader and he recorded where he had been before. Dogs used to be valuable for ice. They learnt to walk on different kinds of ice. Today, you cannot get a skidoo to walk on different kinds of ice. You have to try and analyse that ice yourself, before you go on it with the skidoo. That way you sharpen your sense - senses that were not so sharp before.
>
> William Kalleo, Nain, Labrador, as quoted in "Our Footprints are Everywhere", Ed. by C. Brice-Bennett, Labrador Inuit Association, Labrador, 1977, p. 323.

4.1. The most consistent distinction between Inuit use and southern recreational use is that snowmobiles should be capable of pulling heavy loads over considerable distances, over terrain which is far rougher than groomed trails for which the machines are designed. Three general kinds of use were described by respondents; to a certain extent, shaped by the machines available.

A large machine capable of pulling 1,000 k (2,200 lbs) at slow, steady speeds - chiefly for trapping.

A mid-size machine capable of pulling 450 k (1,000 lbs), but also capable of a fair turn of speed when un-hitched.

A small, maneouverable, machine, economical to operate but still capable of pulling considerable loads through hilly and forested areas.

The machines discussed above in section 3.5 are primarily aimed at the group, 4.1.2. At present, the needs of group 4.1.1. are met with the Bombardier Alpine (the only choice) and the needs of group 4.1.3 are chiefly met by the Bombardier Elan. Both these snowmobiles have been in production for over ten years and retain basic design features which have since been superseded in other models. In that sense they may be regarded as 'utilitarian', but they cannot be regarded as 'state-of-the-art utilitarian' because, for the reasons summarised above, there is none.

4.2. Major types of use are listed below, with the proviso that any single journey may combine any of these activities as circumstances permit or as the opportunities arise.

Fishing through lake or sea ice, usually entailing journeys over the sea ice to and from the fishing place.

Hunting for caribou, musk oxen or wolf, sometimes involving long, unpredictable, trips over land and sea ice surfaces.

Hunting whales, seals, walrus and polar bear. Mostly travel over sea ice.

Trapping, entailing long, regular, journeys, often with heavy loads of traps, spare parts, fuel and supplies.

Travel between settlements or between settlements and outpost camps, sometimes involving the transport of heavy loads of supplies, especially to outpost camps.

4.3. Everyday travelling conditions are consistently more severe than those for which most snowmobiles are designed.

'Normal' tundra snow surfaces in Canada are considerably harder and more damaging even than those in Scandinavia.

Even when the snow cover is most extensive, a traveller will encounter unavoidable stretches of rock outcrops, gravel, etc.

During the spring, terrain conditions are at their worst: on the land, softened snow, mud and exposed tundra; on the sea ice bare rough and ridged ice, collected meltwater and open leads.

4.4. Most respondents estimated that a snowmobile would not provide longer than a single season of "serious" or "regular" use.

After such a season, a snowmobile, after an overhaul, would be suitable for use around the settlement, or as a back-up machine, but cannot really be depended upon for long trips.

Even those full-time trappers on Banks Island, who use the expensive utility Bombardier Alpine, prefer not to use a machine for a second year on the trap-line.

When asked what kind of distance could be considered serious use, most respondents replied in range 8,000-16,000 km (5,000-10,000 mi) though a few estimated higher or lower.

As points of comparison, Hydro-Quebec withdraw their Bombardier Alpines after 7,200-10,800 km (4,500-6,750 mi) - or 2 years of cross-country work; manufacturers estimates of the life-span distance of recreational snowmobiles varied between 11,520 and 17,920 km (7,200 and 11,200 mi).

Many respondents reported that they could not always afford to obtain a new machine each year but the ratios of hunters to new machines provided in section 3.4.4. suggest an average life-span in the range 1.5-2.0 years.

4.5. Sample costs for the three types of snowmobiles described in sections 4.1.1 - 4.1.3 were estimated and projected to 1986 according to the following bases and assumptions.

	large	mid-size	small
price	$5,000	$3,300	$1,700
routine maintenance	300	250	200
annual overhaul	900	800	700
fuel consumption	3 km/li (8 mpg)	5 km/li 14 mpg)	7 km/li 20 mpg)

Fuel costs are based on ¢58/li, to double by 1986.
New price, maintenance and overhaul to rise by 10% p.a.
The estimates worked out for either 6,000 km (3,750 mi) or 12,000 km (7,500 mi) p.a.
Estimates are developed for, one year only, a second year, and two years including an overhaul (Tables 5,6,7).

The cheapest case is running a small machine for two years over a total of 24,000 km yielding costs of ¢20/km (¢32/mi) rising by 70% to ¢34/km (¢54/mi) by 1986.

The most expensive case is running a large machine over 6,000 km in a single year, yielding costs of $1.08/km ($1.73/mi) - rising by 55% to $1.67/km ($2.67/mi) by 1986.

The most common case would be a mid-size machine, for which the costs for a single year of operation vary between $4,246 and $4,942. These estimates are consistent with the answers provided by many respondents to the question, how much does it cost to run a snowmobile each year? "About $5,000".

5. SNOWMOBILES AS WORKING VEHICLES IN THE ARCTIC: COMMENTS UPON PERFORMANCE AND POSSIBLE SCOPE FOR IMPROVEMENT.

There are three reasons why your project won't produce the ideal snowmobile:

1) The manufacturers won't do it because they will go out of business, after which I shall go out of business.

2) It will be to heavy for proper flotation.

3) However strong it was, some of my customers would manage to break it.

Willie Emudluk, Arctic Cat & Yamaha dealer,
George River, Quebec
Interp. Jean-Guy St. Aubin

5.1. Snowmobile dealers and mechanics consistently offered the following general comments on the performance and reliability of snowmobiles under Arctic conditions.

That in terms of reliability, snowmobiles nowadays are less troublesome than they used to be.

Table 5 : SAMPLE OPERATING COSTS FOR A SMALL SNOWMOBILE

	81/82	82/83	83/84	84/85	85/86
First Year					
Purchase	1,700	1,870	2,057	2,263	2,490
Spares	200	220	242	266	293
Fuel/6,000 km	497	617	746	866	994
TOTAL	2,397	2,707	3,045	3,395	3,777
¢/km	0.40	0.45	0.51	0.57	0.63
Fuel/12,000 km	994	1,234	1,492	1,732	1,988
TOTAL	2,894	3,324	3,791	4,261	4,771
¢/km	0.24	0.28	0.32	0.36	0.40
Second Year					
Overhaul	700	770	847	932	1,025
Spares	200	220	242	266	292
Fuel/6,000 km	497	617	746	866	994
TOTAL	1,397	1,607	1,835	2,064	2,312
¢/km	0.23	0.27	0.31	0.34	0.38
Fuel/12,000 km	994	1,234	1,492	1,732	1,988
TOTAL	1,894	2,224	2,581	2,930	3,306
¢/km	0.16	0.18	0.21	0.24	0.27
2 yr total/ 12,000 km	3,794	4,314	4,880	5,459	6,089
¢/km	0.32	0.36	0.41	0.45	0.51
2 yr total/ 24,000 km	4,788	5,548	6,372	7,191	8,077
¢/km	0.20	0.23	0.27	0.30	0.34

2

Table 6 : SAMPLE OPERATING COSTS FOR A MID-SIZE SNOWMOBILE

	81/82	82/83	83/84	84/85	85/86
First Year					
Purchase	3,300	3,630	3,993	4,392	4,831
Spares	250	275	302	337	365
Fuel/6,000 km	696	894	1,044	1,212	1,392
TOTAL	4,246	4,769	5,339	5,941	6,588
¢/km	0.71	0.79	0.89	0.99	1.10
Fuel/12,000 km	1,392	1,728	2,088	2,424	2,784
TOTAL	4,942	5,633	6,383	7,153	7,980
¢/km	0.41	0.47	0.53	0.60	0.66
Second Year					
Overhaul	800	880	976	1,047	1,181
Spares	250	275	302	337	365
Fuel/6,000 km	696	864	1,044	1,212	1,392
TOTAL	1,746	2,019	2,322	2,596	2,938
¢/km	0.29	0.34	0.39	0.43	0.49
Fuel/12,000 km	1,392	1,728	2,088	2,424	2,784
TOTAL	2,442	2,883	3,366	3,808	4,330
¢/km	0.20	0.24	0.28	0.32	0.36
2 yr total/ 12,000 km	5,992	6,788	7,661	8,537	9,526
¢/km	0.50	0.57	0.64	0.71	0.79
2 yr total/ 24,000 km	7,380	8,516	9,749	10,961	12,310
¢/km	0.31	0.35	0.41	0.46	0.51

Table 7: SAMPLE OPERATING COSTS FOR A LARGE SNOWMOBILE

	81/82	82/83	83/84	84/85	85/86
First Year					
Purchase	5,000	5,500	6,050	6,655	7,260
Spares	300	330	363	399	438
Fuel/6,000 km	1,160	1,440	1,740	2,020	2,320
TOTAL	6,460	7,270	8,153	9,074	10,018
$/km	1.08	1.21	1.36	1.51	1.67
Fuel/12,000 km	2,320	2,880	3,480	4,040	4,640
TOTAL	7,620	8,710	9,893	11,094	12,338
$/km	0.63	0.73	0.82	0.92	1.03
Second Year					
Overhaul	900	990	1,089	1,198	1,318
Spares	300	330	363	399	438
Fuel/6,000 km	1,160	1,440	1,740	2,020	2,320
TOTAL	2,260	2,760	3,192	3,617	4,076
$/km	0.39	0.46	0.53	0.60	0.68
Fuel/12,000 km	2,320	2,880	3,480	4,040	4,640
TOTAL	3,520	4,200	4,932	5,637	6,396
$/km	0.29	0.35	0.41	0.47	0.53
2 yr total/ 12,000 km	8,820	10,030	11,345	12,691	14,094
$/km	0.73	0.84	0.94	1.06	1.17
2 yr total/ 24,000 km	11,140	12,910	14,824	16,731	18,734
$/km	0.46	0.54	0.62	0.70	0.78

2

That the problems that do develope are usually due either to the extreme severity of the operating environment, or to improper care and maintenance on the part of owners.

It appears that, with the appearance of more dependable machines, the emphasis may be shifting from reliability to utility performance.

Remarks such as these were frequently made with qualifications, either addressed to specific makes or models, or failings which most available snowmobiles had in common. The most frequent example of the latter was that snowmobiles tracks are in general too narrow and should be 2.5-5.0 cm (1-2 in) wider.

The most knowledgeable users understood that the principle orientation in snowmobile research and development was recreational and for that reason were not surprised that machines could not take the wear and tear of Arctic operation. Nevertheless, they did not dismiss all recent developments as impairing utility performance, but pointed out that some were of benefit for both recreational and utility use.

5.2. Below, this distinction is applied to a consideration of the major changes in snowmobile design since the 1960's.

Engine development has been directed towards improving power to weight ratios and reducing noise. As a result, twin cylinder engines have replaced single-cylinder types, with a loss of torque. However, current engines are superior in terms of fuel efficiency and reliability.
Manufacturers are presently aiming at increasing fuel efficiency still further, and, for some dual purpose machines, single-cylinder engines, or de-tuned larger engines will be made available.

Cooling systems development has also aimed at increasing power output and reducing noise and liquid cooling once tended to displace free-air for this reason. This system carries a cost/weight penalty. Subsequently, fan-cooling improved and is replacing liquid cooling, except for high performance machines. Fan-cooling is the most cost-effective method for utility use.

In fuel supply, the most significant change has been from pre-mixing to automatic mixing with oil injection systems. Users were equivocal about the benefits of oil injection. Early systems would fail at very low temperatures and lead to engine seizure. Improved systems employ more miscible, and expensive oil, but some users still prefer to rely on pre-mixing. Carburetion has improved significantly over the years, with better cold starting, smoother operation and lower fuel consumption.

Ignition systems have, over the years, largely converted from contact breaker/magneto types to capacitor discharge systems. At first, these were unreliable and frustrating to repair on the trail. They have since improved and the performance they deliver is preferred to that of breakers.

Starter systems are either manual, electric or dual. Electric systems entail a cost/weight penalty and introduce the problem of battery maintenance on cold weather. They were not regarded as necessary for utility use.

The engine mounting has progressively moved forward, off the tunnel (the basic structural element) and to the bottom plate, which now supports both the engine and the front suspension and skis. This has entailed much reinforcement of the plate and its attachments to the tunnel.
While a forward mounted engine improves steerage, both on groomed trails and tundra snow, such an improvement could be achieved by extending the tunnel forward; the low-slung engine mounting has been developed largely for 'styling' reasons. Low-slung, engines do not improve utility performance, in fact they may expose the engines to more damage in rough terrain.

Transmissions have improved considerably over the years as manufacturers have learnt from practical experience how better to calibrate the systems.
The final transmission of power to the track through the final drive sprocket has improved with the addition of free-wheeling idler wheels and improved track materials.

Suspension systems have undergone a general transition from bogie to slider systems. Sliders provide better performance on groomed trails, particularly at speed. They have longer travel, improving comfort and reduce track wear through deformation. However, they are more expensive than bogies. Bogies are tougher and allow travel on a wider variety of terrain types, but are responsible for inducing fatigue and sometimes back injury.
A research program to improve the riding qualities of bogie systems could improve utility performance by broadening terrain versatility at lower costs. However, once the commitment to sliders had been made such a program would have been redundant as far as recreational performance is concerned.

Three track types have emerged over time: (1) internally reinforced rubber, (2) rubber with external metal cleating, (3) moulded plastic. The first type has proven to provide the best all-round performance, for recreational and utility uses.

However, changes in track dimensions have not been of comparable benefit for utility use. Table 3 shows the convergence in track width that has occurred over the years. Most users consulted in this study held the view that tracks should be wider. For utility usage, the manufacturers have lengthened tracks instead, a more economical measure. It remains to be seen which approach is the more effective.

Changes in snowmobile bodies have been chiefly in the materials used and the actual shape. Aluminium, fibreglass and polycarbonate materials have all been introduced without any special benefit for utility performance.
Seat design has improved considerably, to some extent in compliance with safety standards designed to reduce impact on the riders' backs.

It is conceivable, that such improvements could be taken yet further, for example, in compensating for the hard ride provided by bogie suspension systems.
However, it seems that the design of seats, cabins, the whole snowmobile, is dominated by styling rather than functional considerations. To that extent, utility performance suffers.

5.3. Consideration was given to snowmobiles which: were advertised or projected as dual-purpose machines, had acquired a reputation as such, or were the most economical (12 models, Table 8).

Most of these machines have derived benefits from design and engineering advances since the 1960's as far as engine efficiency, cooling, carburetion, ignition and track materials are concerned.

However, with regard to body design, engine mounting, track dimensions and suspension systems, the dual-purpose machines, in their 'utility' role, have been limited by the scope for modification exhibited by these design elements on the recreational models from which they were derived.

6. SCOPE FOR IMPROVING UTILITY SNOWMOBILES THROUGH AN R&D PROGRAM

6.1. An R&D program should at first have two principle objectives:

An investigation of the economics of producing a utility snowmobile through a simplified modular assembly process and a comparison of those economics with the production processes employed by the current manufacturers.

An investigation of those avenues of research into utility performance that have received low priority during the development of the recreational potential of snowmobiles.

6.2. To give concrete shape to the possibilities, "outline specifications for a mid-size modular utility snowmobile" were proposed.

These specifications suggest how the technical advances that improve utility performance, and advances in materials, may be integrated with the simplicity of construction of the 1960's.

The resulting machine would be simple, durable and readily overhauled, but would be ugly and slow compared with current dual-purpose machines. To be competitive, it would probably have to offer significant advantages in performance and costs. In collaborating on such a project, and in generating acceptance, there is much scope for participation by Inuit.

Table 8 : SALIENT FEATURES OF UTILITY AND MULTI-PURPOSE MODELS FOR 1982/83

Model Names S:small M:medium L:large	Displacement cc	No. Cyl.	Weight kgs	Starter (M) manual (E) electric	Ignition (C) CDI (B) breaker	No. Carbs.	Fuel Mix (I) injection (P) pre-mix	Cooling (F) fan	Ski Stance	Track length cm	Track width cm	Track area cm^2	Suspension (B) bogie (S) slider
Bombardier													
S ELAN	250	1	285	M	B	1	P	F	25.5	292	38.4	11,206	B
M NORDIK	368	2	380	M	C	1	P	F	30.0	317	38.4	12,189	S
M SCANDIC	268	1	269	M	C	1	P	F	32.2	356	38.4	13,664	S
M SCANDIC	368	2	386	M	C	1	P	F	32.2	356	38.4	13,664	S
M EVEREST	497	2	458	M	C	1	P	F	33.5	317	42.2	13,377	S
L ALPINE	635	2	645	E	B	1	P	F	single	356	76.8	27,340	B
Yamaha													
S BRAVO	246	1	282	M	C	1	I	F	34.3	238	38.4	9,143	S
M 340	338	2	364	M	C	1	I	F	33.5	279	38.4	10,715	S
M 340TF	338	2	387	M	C	1	I	F	31.5	346	38.4	13,271	S
John Deere													
M TRAILFIRE SPECIAL	339	2	388	N/A	C	1	P	F	30.0	294	40.3	11,864	S
Polaris													
S GEMINI	250	1	N/A	M	C	1	P	F	N/A	294	38.4	11,289	S
M SSLT	440		N/A	M	C	1	P	F	N/A	379	38.4	14,548	S

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